

Title

Potential SSP Perfluorooctanoic Acid Related Fluoropolymer Materials
Obsolescence

PFOA Abstract

The Shuttle Environmental Assurance Initiative (SEA) has identified a potential for the Space Shuttle Program (SSP) to incur materials obsolescence issues due to agreements between the fluoro-chemical industry and the United States Environmental Protection Agency (USEPA) to participate in a Global Stewardship Program for perfluorooctanoic acid (PFOA). This presentation will include discussions of the chemistry, regulatory drivers, affected types of fluoropolymer and fluoroelastomer products, timeline for reformulations, and methodology for addressing the issue. It will cover the coordination of assessment efforts with the International Space Station and Head Quarters Air Force Space Command, along with some examples of impacted materials. The presentation is directed at all members of the international aerospace community concerned with identifying potential environmentally driven materials obsolescence issues.

Copyright © 2006 by United Space Alliance, LLC. These materials are sponsored by the National Aeronautics and Space Administration under Contract NAS9-20000. The U.S. Government retains a paid-up, nonexclusive, irrevocable worldwide license in such materials to reproduce, prepare, derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the U.S. Government. All other rights are reserved by the copyright owner.

Potential SSP Perfluorooctanoic Acid Related Fluoropolymer Materials Obsolescence



Matt Segars
United Space Alliance
**Shuttle Environmental Assurance/
Propulsion Systems Engineering & Integration**

11/02/2005

Draft

Outline

- **Overview**
- **Chemistry**
- **Process Overview**
- **Regulatory/Timeline Drivers**
- **Implications of Regulatory Language**
- **Identified Changes to Materials & Processes**
- **Impacts to NASA**
- **How We Are Addressing the Issue**

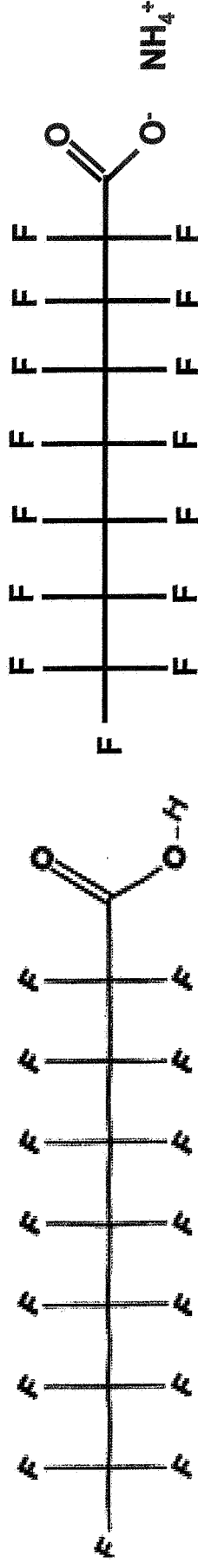
Overview

- Perfluorooctanoic Acid (PFOA) is a surfactant used as a processing aid in the production of fluoropolymer and fluoroelastomer materials (PTFE, FEP, PFA, THV, ETFE, HTE, PVDF).
- PFOA has been found in the general population; is bio-persistent and a possible carcinogen; and may be linked to other health issues.
- The “Global Stewardship Program for PFOA” is not a traditional EPA regulation but rather an Industrial Agreement.
- The 8 major domestic/international fluoropolymer producers, 3M/Dyneon, Arkema Inc., AGC Chemicals/Asahi Glass, Ciba Specialty Chemicals, Clariant Corporation, Daikin, E.I. duPont de Nemours and Company, and Solvay Solexis, have committed to the Stewardship Program.

Chemistry

Two processes used to produce fluorinated chemicals

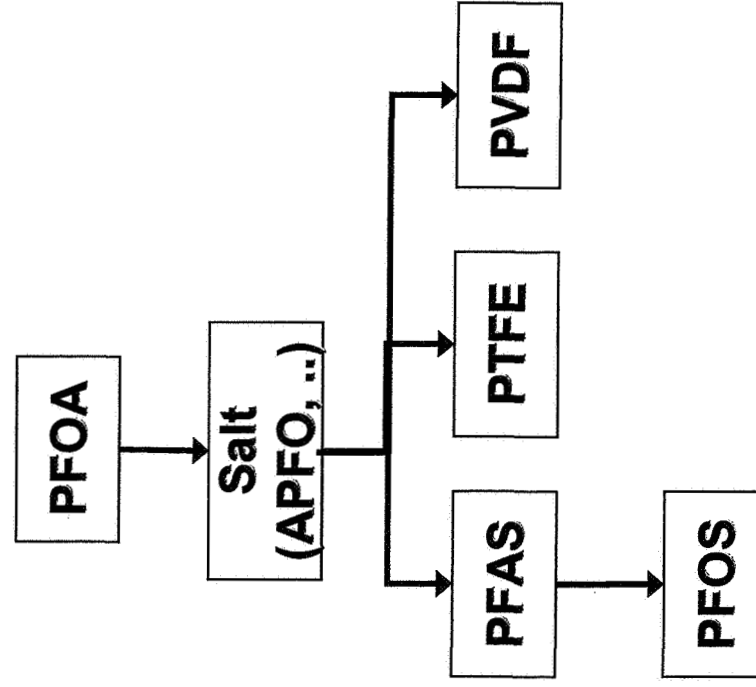
- **Electrochemical Fluorination (ECF)** – Majority of fluoropolymers/fluoroelastomers produced by this method
 - PFOA is usually converted to one of its salts such as APFO, which serves as a surfactant in the reaction.
- **Telomerization** – Used primarily as paper and fabric protectors
 - PFOA is a byproduct of the Telomerization process.



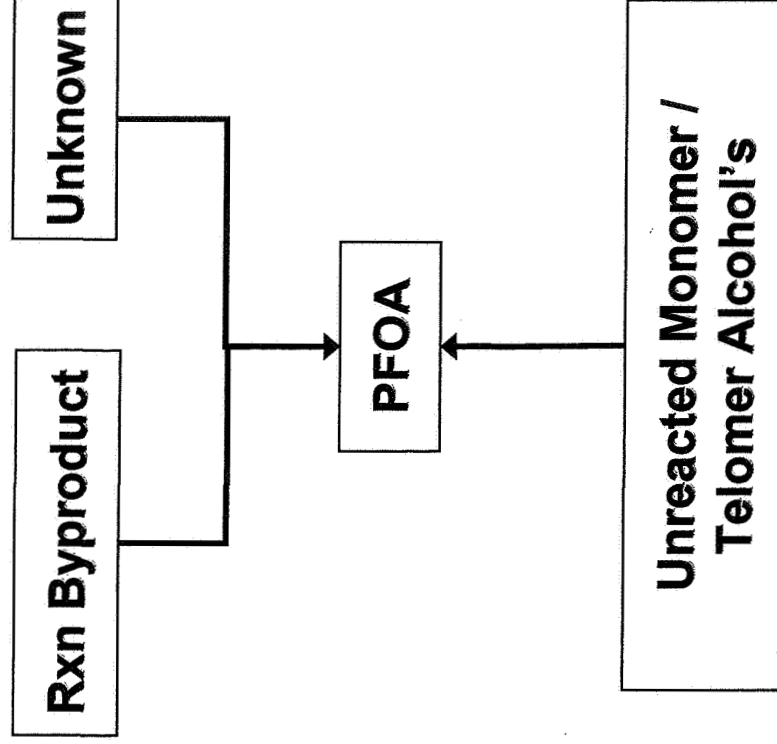
- Perfluorooctanoic acid
- Ammonium perfluorooctanoate (APFO)

Process Overview

• ECF Process



• Telomerization Sources of PFOA



Regulatory/Timeline Drivers

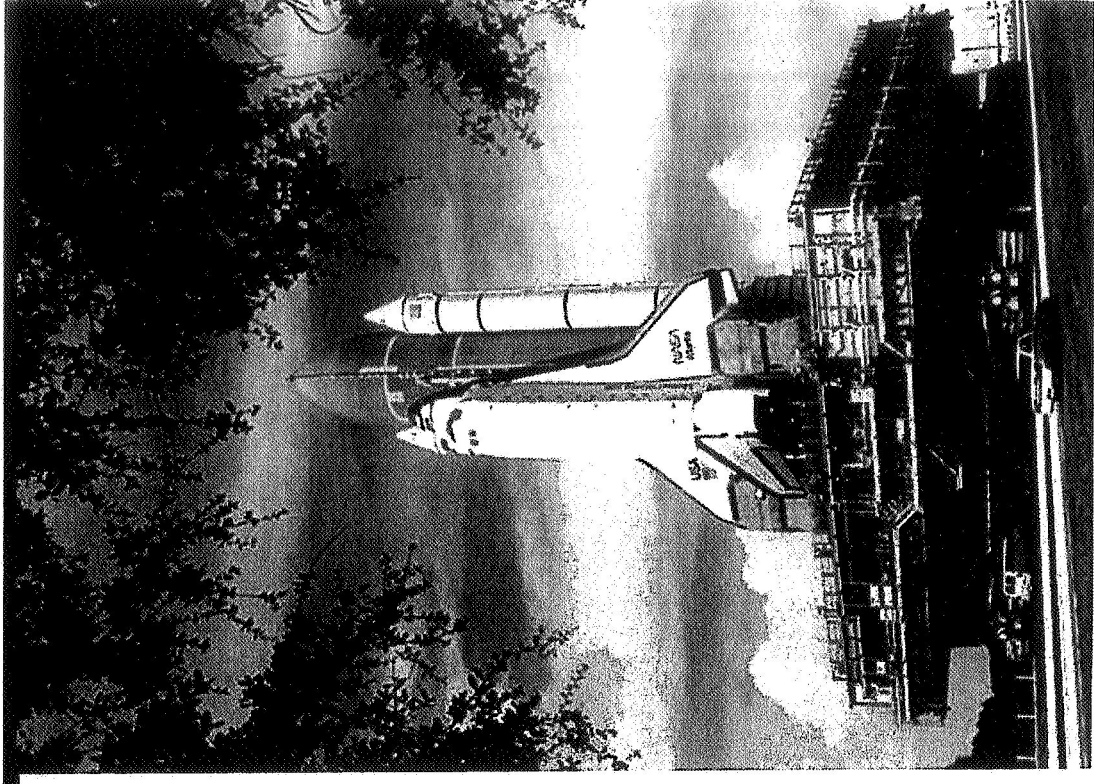
- **EPA's Global Stewardship Program for PFOA**

—“To commit to achieve, no later than 2010, a 95 % reduction, measured from a year 2000 baseline, in *both*: facility emissions to all media of PFOA, precursor chemicals that can break down to PFOA, and related higher homologue chemicals, *and product content levels of PFOA*, precursor chemicals that can break down to PFOA, and related higher homologue chemicals”.

- **EPA Toxic Substances Control Act (TSCA) Section 4, Enforceable Consent Agreements (ECA) and Memorandum of Understanding (MOU) are driving exposure route testing.**
- **Industrial Phase-out Schedule - Most manufacturers are working toward a 90% reduction in their Aqueous Dispersion (AD) lines before CY07.**

Implications of Regulatory Language

- **“Product Content Levels”**
 - Aqueous Dispersions
- **“Facility Emissions to All Media”**
 - Process Efficiency / Byproducts / Waste
- **ECAs and MOUs**
 - Testing of breakdown products and exposure routes
 - Telomers are suspect

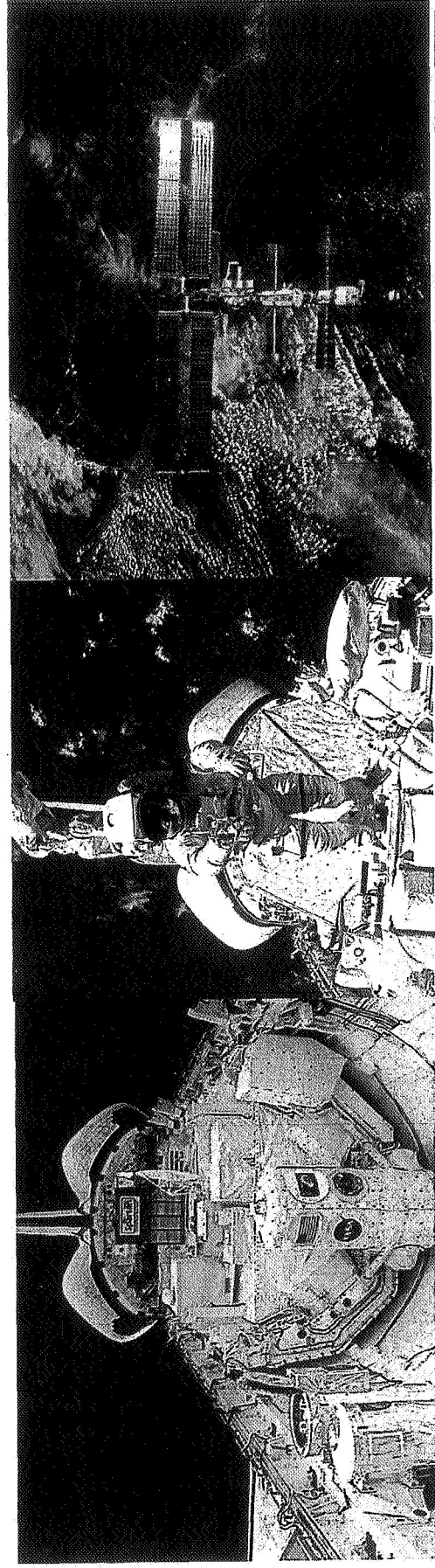


Identified Changes to Materials Processes

- **Aqueous Dispersions (2 different routes of reduction)**
 - Additional processing - a final wash step to remove PFOA and replace with a different surfactant
 - Reformulation - Replacing PFOA in the reaction step
- **Elastomers (small amounts of PFOA in the final product)**
 - Reformulation - Replacing PFOA in the reaction step
- **Polymers (i.e. plastics)**
 - No changes identified at this time.
- **Fluorotelomers**
 - No changes identified at this time.

Impacts to NASA

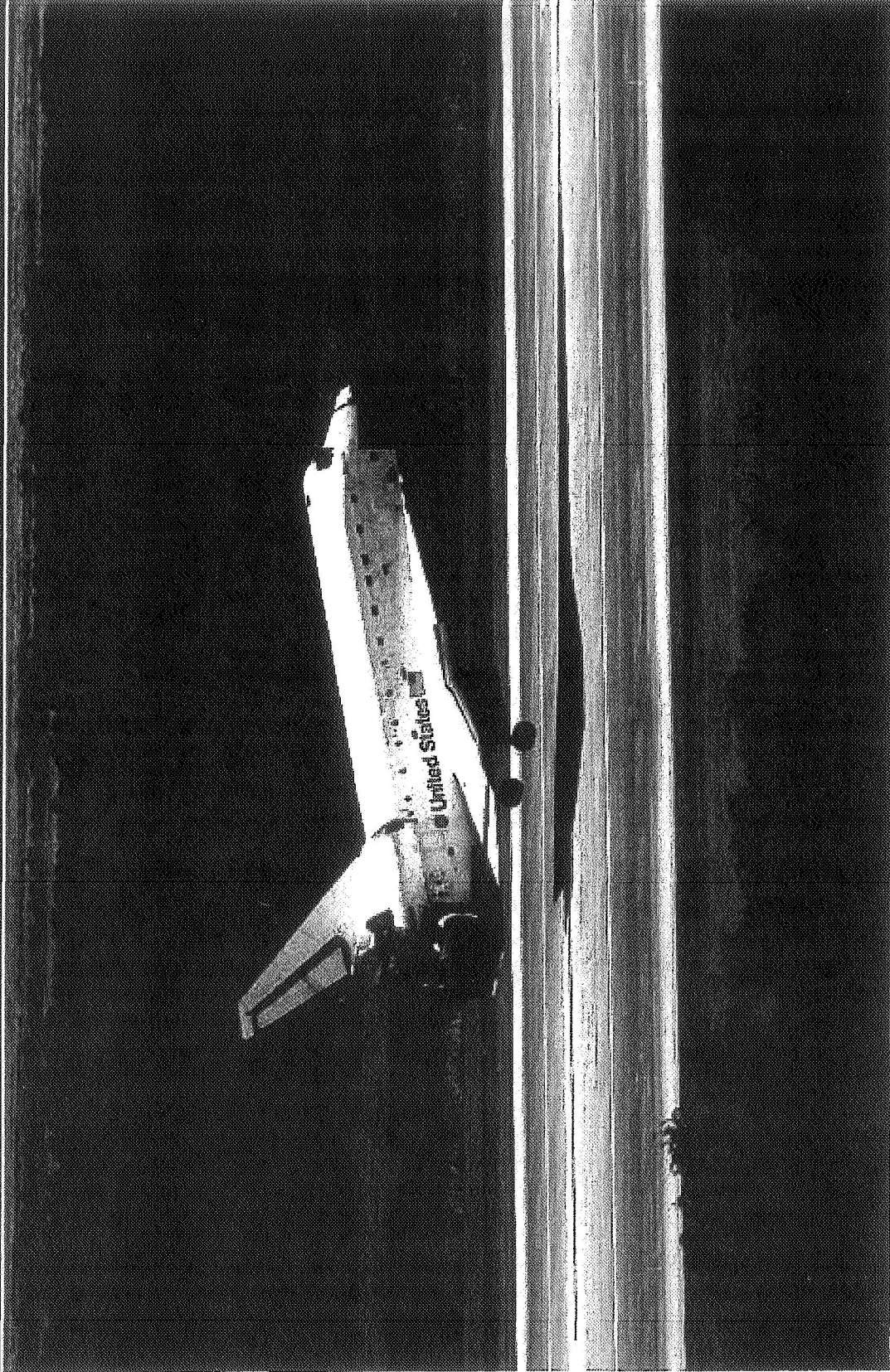
- The SSP was informed that the beta cloth used to make payload bay thermal control blankets would be reformulated in September '06.
- The SSP has identified multiple flight hardware and tooling dispersion coatings on the Dupont CY06 reformulation list.
- The International Space Station (ISS) identified Teflon T30 used in batteries as a catalyst binder as reformulated in December '05 with a 6 month shelf life.
- NASA could have potential impacts in coatings, tapes, insulations, tubing, thread packing materials, cables/wires, and seals/o-rings.



How We Are Addressing the Issue

- **NASA formed a team to assess the PFOA Impacts to the SSP**
 - **Composed of SSP and Air Force Space Command representatives**
 - **Working to determine the integrated SSP risk associated with the PFOA Global Stewardship Program and develop a mitigation plan. Team is working to identify materials subject to reformulation.**
- **NASA formed a team to assess the PFOA Impacts to the ISS**
 - **Team composed of ISS and SSP representatives**
 - **Working to identify critical ISS applications of fluoropolymer materials with reformulation or process change potential. Current focus is on DuPont (Largest producer of PTFE and Fluoromer blends “Teflon™”).**
- **Teams are working together to identify commonality and integrate efforts where possible.**

Questions?



11/02/2006
SEA PFOA @ P2

Page 11

Draft

USA
United Space Alliance

Backup

- **Definitions**
- **Polymer Acronyms**

Definitions

- **Higher Homologue Chemicals:** PFOA is an eight-carbon chain length chemical. Chemicals similar in structure to PFOA but with nine or more carbons in the chain would be higher homologues of PFOA.
- **Precursor:** A chemical that can break down to form another chemical, in this case, PFOA. For example, some residual monomer chemicals from the telomer manufacturing process such as telomer alcohols and telomer iodides may remain in the final product and break down into PFOA.
- **Aqueous Dispersions:** A liquid system in which very small solid particles (in this case fluoropolymer) are uniformly dispersed in water.
- **Surfactant:** A substance capable of reducing the surface tension of a liquid in which it is dissolved. It tends to dissolve in both the aqueous and oil phase and to locate at the oil-water interface.

Polymer Acronyms

- PTFE – polytetrafluoroethylene
- FEP – fluorinated ethylene-propylene
- PFA – perfluoroalkoxy
- THV – tetrafluoroethylene, hexafluoropropylene and vinylidene fluoride
- ETFE – ethylene tetrafluoroethylene
- HTE – hexafluoropropylene, tetrafluoroethylene, and ethylene
- PVDF - polyvinylidene difluoride or polyvinylidene fluoride